FORM PTO-1390 (REV 10-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: KONIG-003

US APPLICATION NO (If known, see 37 CFR 1 5): 09/830896

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/03384	22 October 1999	3 November 1998

TITLE OF INVENTION: Method for Adjusting the Fuel Concentration of a Fuel Mixture Containing Alcohol or Ether as Fuel and Water, Used...

APPLICANT(S) FOR DO/EO/US: Dieter Meissner et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. [X] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [XX] Other items or information:
    a) One Sheet of Drawings
    b) Express Mail Certification
    c) Return Postcard

U.S. APPLICATION NO (if known, see 37 CFR 1.5) 09/830896	INTERNATIONAL APPLICATION NO PCT/DE99/03384	ATTORNEY'S DOCKET NUMBER KONIG-003

17. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**

	CALCULATIONS PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ -0-

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	15 - 20 =	0	X **$18.00**	$ -0-
Independent claims	2 - 3 =	0	X **$80.00**	$ -0-
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.0**	$ 270.00
TOTAL OF ABOVE CALCULATIONS =				$ 1,130.00
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$ -0-
SUBTOTAL =				$ 1,130.00
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ -0-
TOTAL NATIONAL FEE =				$ 1,130.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ -0-
TOTAL FEES ENCLOSED =				$ 1,130.00
			Amount to be refunded:	$
			charged:	$

a. [ ] A check in the amount of $_____ to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. 19-1218 in the amount of $1,130.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 19-1218. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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SIGNATURE

Ralph W. Selitto, Jr.
NAME

26,996
REGISTRATION NUMBER

Method for regulating the fuel concentration in a fuel mixture of a fuel cell which contains alcohol or ether as fuel and water, and fuel cell system

Description

The invention relates to a method for regulating the fuel concentration in a fuel mixture for a fuel cell which is formed by an alcohol or an ether as fuel and water, and to a fuel cell system, containing at least one fuel cell, which can be operated with a fuel mixture consisting of an alcohol or an ether as fuel and water, and at least one mixing space, which is connected to in each case one controllable fuel inlet, and at least one fuel-mixture feedline, which connects the at least one mixing space to in each case the at least one fuel cell.

At the date of this application, fuel cell systems of the abovementioned type have already been known for over 30 years (cf. for example *W. Vielstich; "Brennstoffelemente" [Fuel Elements] Verlag Chemie, Weinheim 1965, pages 73-93* and *L. Oniciu; "Fuel Cells", Abacus-Press, Kent, 1976, pages 93-98)*. The alcohol, for example methanol, as fuel, mixed with water to form a fuel mixture, is fed to a fuel cell, where it is directly converted into electrical energy. Alcohol contents of between 1% by volume and 5% by volume in the fuel mixture have proven particularly advantageous for operation of a fuel cell of this type. One problem with the operation of fuel cells of this type is that of keeping the alcohol concentration of the fuel mixture as constant as possible. This applies equally to fuel cells which use alcohol and fuel cells which use ether as the fuel.

DE 197 01 560 A1 has disclosed a fuel cell system in which a liquid fuel mixture comprising a fuel and a coolant is fed to the anode space of a fuel cell. DE 196 28 888 C1 discloses a fuel cell which can be operated, inter alia, with a fuel mixture of fuel and

water. In this case, the efficiency of the fuel cell is increased by an alternating operating pressure. DE 44 25 634 C1 has disclosed a method and a device for the metered supply of methanol and/or water from a reservoir, via a conveyor pipe, to a fuel cell system. In this case, a delivery pump is used to convey a constant mass flow rate from the reservoir into the conveyor line, and the differential pressure between conveyor line and fuel cell system is set to a predetermined value with the aid of a differential pressure regulator, so that the quantity of methanol and/or water supplied can be set, for example, by varying the opening and closing times of a solenoid valve. The abovementioned prior art fails to disclose either a method or a device for regulating the fuel concentration in the fuel mixture.

DE 35 08 153 has disclosed the regulation of the concentration of the fuel within a fuel mixture using a fuel cell which is operating in idling mode. This document exploits the fact that the idling potential of a fuel cell is dependent on the fuel concentration. However, this type of regulation is highly complex and therefore very expensive.

It is now an object of the present invention to provide a method of the type described in the introduction which is simpler than the prior art and at the same time is effective, and to provide a fuel cell system which is suitable for carrying out this method.

With regard to a method for regulating the fuel concentration in a fuel mixture of a fuel cell which contains an alcohol or ether and water, this object is achieved by the fact that the fuel is fed via a controllable fuel inlet to a mixing space, from where the fuel mixture is fed, via a fuel-mixture feedline, to the fuel cell via a membrane which is arranged downstream of the fuel inlet, as seen in the direction of flow, delimits a measurement chamber and is selectively permeable to water and the fuel, a liquid or gaseous measurement mixture with a fuel

concentration of less than 1% by volume or more than 5% by volume, depending on the quantity of fuel which permeates into the measurement chamber from the fuel mixture per unit time, being produced in the measurement chamber, whereupon the fuel concentration in the measurement mixture is determined and the fuel inlet is controlled as a function of the fuel concentration in the measurement mixture.

Therefore, the regulation is achieved by the fact that it is not directly the fuel concentration in the fuel mixture which is determined, but rather the fuel concentration in a measurement mixture in which the fuel concentration is within a range which can be measured with sufficient accuracy and speed using known sensors. The fuel concentration in the measurement mixture is directly dependent on the fuel concentration in the fuel mixture, so that it can be controlled by measuring the fuel content in the measurement mixture.

The method according to the invention can be carried out in such a way that, to produce the measurement mixture in the measurement chamber, a carrier liquid or a carrier gas is used to dilute and/or remove the permeated fuel. The permeated fuel can also be consumed at electrodes in the measurement chamber, so that it is not imperative that the fuel be removed by the carrier liquid or the carrier gas. The specified fuel concentrations can also be achieved even without a carrier liquid or a carrier gas, by means of suitable membranes: for example, the membrane may be more permeable to the fuel than to water by more than one order of magnitude, so that a measurement mixture with a fuel concentration of less than 1% by volume even down to the ppm range can be formed in the measurement chamber from the permeated fuel and the permeated water. Conversely, if the permeability of the membrane is higher for water than for the fuel, it is possible to form measurement mixtures in which the fuel concentration is over 5, preferably over 10% by volume. Membranes which are suitable for this purpose are known

(cf. for example *H. Strahtmann; "Membranes and Membrane Separation processes", B. Elvers, S. Hawkins, G. Schulz (Ed.); "Ullmanns Encyclopedia of Industrial Chemistry", Vol. A. 16. VCH, Weinheim, 1990, pages 187-263*).

The method according to the invention may also be implemented in such a way that the fuel concentration of the measurement mixture, in the case of values above 10 or 5% by volume, is determined by means of a liquid sensor.

The method according to the invention may also be carried out in such a way that the fuel concentration of the measurement mixture is determined by means of density or viscosity measurements.

The method according to the invention may also be carried out in such a way that the fuel concentration of the measurement mixture is determined by means of optical methods, for example by means of infrared absorption. Optical sensors which are suitable for this purpose, in particular for assessing the CH vibrations of the fuel, are also known (cf. for example *A. Brittain et al. (Ed.) "Optically Based Methods for Process Analysis", S. PIE Proceedings Vol. 1681, Somerset, NJ, USA, 1992*).

The method according to the invention may also be carried out in such a way that the fuel concentration of the measurement mixture, in the case of values below 1.0 or 0.1% by volume, is determined by means of a gas sensor. A gas sensor of this type has a semiconductor element which changes its electrical properties as a function of the concentration of the fuel. A gas sensor of this type and its use in a measurement chamber delimited by a silicone membrane is likewise known in connection with bioreactors (cf. *FMC-Handbuch der Biotechnologie [FMC Biotechnology Manual] Kempe GmbH, Berlin*). Furthermore, it is in this case possible to carry out the determination by recording the conductivity and by infrared absorption.

In a fuel cell system of the type described in the introduction, the abovementioned object is achieved by the fact that the fuel cell system has at least one measurement probe, which is arranged downstream of the fuel inlet, as seen in the direction of flow of the fuel mixture, and comprises

a) a measurement chamber,

b) a membrane which delimits the measurement chamber, is in contact with the fuel mixture, is selectively permeable to the fuel and/or water and is used to produce a liquid or gaseous measurement mixture with a fuel concentration of less than 1% by volume or more than 5% by volume depending on the quantity of fuel which has permeated into the measurement chamber from the fuel mixture per unit time, and

c) a sensor for determining the fuel concentration in the measurement mixture,

and that the fuel cell system has means for controlling the fuel inlet as a function of the fuel concentration in the measurement mixture.

The invention furthermore provides for the sensor to be a gas, liquid, infrared absorption, density measurement, optical or conductivity measurement sensor.

In the text which follows, an embodiment or a configuration is described, by way of example, for the methods according to the invention and the fuel cell systems according to the invention in connection with methanol combustion. In the drawing:

Fig. 1 diagrammatically depicts the structure of a fuel cell system which uses methanol as fuel, and

Fig. 2 diagrammatically depicts an enlarged excerpt from the arrangement shown in Fig. 1, with a measurement probe coupled to a fuel-mixture feedline.

The fuel cell system shown in Fig. 1, which uses methanol as fuel, comprises a fuel cell 1 with a fuel chamber 2 and a reactant chamber 3. The fuel mixture, which consists of methanol and water, is fed to the fuel chamber 2 via the fuel-mixture feedline 4, the methanol concentration in the fuel mixture amounting to approximately 4% by volume. The reactant chamber 3 is supplied with air via a reactant feedline. The exhaust gas, which is a water/air mixture, is discharged from the reactant chamber 3 via the exhaust-gas line 6.

The fuel mixture, in which the methanol level has been reduced by the amount consumed, is discharged from the fuel chamber 2 via the residual fuel discharge line 7 and is passed to an intermediate store 8. A recycling pump 9 is connected to the intermediate store 8, via which pump the fuel mixture of reduced methanol content is pumped into the fuel-mixture feedline 4 and therefore to the fuel chamber 2. The fuel mixture is therefore circulated.

To enable the fuel mixture which enters the fuel chamber 2 to have the requisite methanol concentration, methanol is pumped out of a methanol store 10, via a methanol pump 11, into a mixing space 12, where it is mixed with the fuel mixture of reduced methanol content from the intermediate store 8. The mixing space 12 is symbolically represented in enlarged form in Fig. 1 but may actually also simply be a part of the fuel-mixture feedline 4. The pumping capacity of the methanol pump 11 is controllable.

To be able to ensure that the methanol content of the fuel mixture which enters the fuel chamber 3 is as constant as possible, the methanol concentration is regulated. To do this, a parameter which is directly dependent on the methanol concentration in the fuel mixture is measured. The area surrounded by a dashed circle in Fig. 1 is shown on an enlarged scale in Fig. 2. Fig. 2 shows a measurement probe 13 which is fitted to the fuel-mixture feedline 4. The measurement probe

13 has a membrane 14 which is in direct contact with the fuel mixture flowing past. The membrane 14 is selectively permeable to water and methanol, in such a manner that a measurement mixture which consists of water and methanol and has a methanol content in the ppm range is formed in the measurement chamber 16 which is delimited by the walls 15 of the measurement probe 13 and of the membrane 14. In the measurement chamber 16 there is a methanol sensor 17 which is highly effective in this concentration range. The measured variable which is generated by the methanol sensor 17 as a function of the methanol concentration in the measurement mixture is transmitted via the measurement line 18 to a control unit 19 (Fig. 1) which therefore controls the methanol pump 11 as a function of the methanol concentration in the measurement mixture. Since the methanol concentration in the measurement mixture is directly dependent on the methanol concentration in the fuel mixture in the fuel feedline 4 at the location of the measurement probe 13, this control arrangement can be used to maintain a substantially constant methanol concentration in the fuel mixture.

List of reference numerals

1 Fuel cell
2 Fuel chamber
3 Reactant chamber
4 Fuel-mixture feedline
5 Reactant feedline
6 Exhaust-gas line
7 Residual fuel discharge line
8 Intermediate store
9 Recycling pump
10 Methanol store
11 Methanol pump
12 Mixing space
13 Measurement probe
14 Membrane
15 Wall
16 Measurement chamber
17 Methanol sensor
18 Measurement line
19 Control unit

Claims

1. Method for regulating the fuel concentration in a fuel mixture for a fuel cell which is formed by an alcohol or an ether as the fuel and water, characterized in that the fuel is fed via a controllable fuel inlet (11) to a mixing space (12), from where the fuel mixture is fed, via a fuel-mixture feedline (4), to the fuel cell (1) via a membrane (14) which is arranged downstream of the fuel inlet (11), as seen in the direction of flow, delimits a measurement chamber (16) and is selectively permeable to water and the fuel, a liquid or gaseous measurement mixture with a fuel concentration of less than 1% by volume or more than 5% by volume, depending on the quantity of fuel which permeates into the measurement chamber (16) from the fuel mixture per unit time, being produced in the measurement chamber (16), whereupon the fuel concentration in the measurement mixture is determined and the fuel inlet (11) is controlled as a function of the fuel concentration in the measurement mixture.

2. Method according to Claim 1, characterized in that a liquid or gaseous measurement mixture with a fuel concentration of less than 0.1% by volume depending on the quantity of fuel which has permeated into the measurement chamber (16) from the fuel mixture per unit time is produced in the measurement chamber (16).

3. Method according to Claim 1, characterized in that a liquid or gaseous measurement mixture with a fuel concentration of more than 10% by volume which is dependent on the quantity of fuel which has permeated into the measurement chamber (16) from the fuel mixture per unit time is produced in the measurement chamber (16).

4. Method according to one of the preceding claims, characterized in that to produce the measurement mixture in the measurement chamber (16) a

carrier liquid or a carrier gas is used to dilute and/or remove the permeated fuel.

5. Method according to one of the preceding claims, characterized in that the fuel concentration of the measurement mixture, in the case of values above 10 or 5% by volume, is determined by means of a liquid sensor.

6. Method according to Claim 5, characterized in that the fuel concentration of the measurement mixture is determined by means of density or viscosity measurements.

7. Method according to Claim 5, characterized in that the fuel concentration of the measurement mixture is determined by means of optical methods.

8. Method according to Claim 7, characterized in that the fuel concentration of the measurement mixture is determined by means of infrared absorption.

9. Method according to one of Claims 1 to 4, characterized in that the fuel concentration of the measurement mixture, in the case of values below 1.0 or 0.1% by volume, is determined by means of a gas sensor.

10. Method according to Claim 9, characterized in that the fuel concentration of the measurement mixture is determined by means of optical methods or by determining the conductivity.

11. Method according to Claim 9, characterized in that the fuel concentration of the measurement mixture is determined by means of infrared absorption.

12. Fuel cell system, containing at least one fuel cell (1), which can be operated with a fuel mixture consisting of an alcohol or an ether as fuel and water, and at least one mixing space (12), which is connected to in each case one controllable fuel inlet (14), and at least one fuel-mixture feedline (4), which connects the at least one mixing space (12) to in each case the at least one fuel cell (1), characterized in that the fuel cell system has at least one measurement probe (13), which is arranged downstream of the fuel inlet

(11), as seen in the direction of flow of the fuel mixture, and comprises

a) a measurement chamber (16),

b) a membrane (14) which delimits the measurement chamber (16), is in contact with the fuel mixture, is selectively permeable to the fuel and/or water and is used to produce a liquid or gaseous measurement mixture with a fuel concentration of less than 1% by volume or more than 5% by volume depending on the quantity of fuel which has permeated into the measurement chamber (16) from the fuel mixture per unit time, and

c) a sensor (17) for determining the fuel concentration in the measurement mixture,

and in that the fuel cell system has means (19) for controlling the fuel inlet (11) as a function of the fuel concentration in the measurement mixture.

13. Fuel cell system according to Claim 12, characterized in that a gas, liquid, infrared absorption, density measurement, optical or conductivity measurement sensor is provided as the sensor (17).

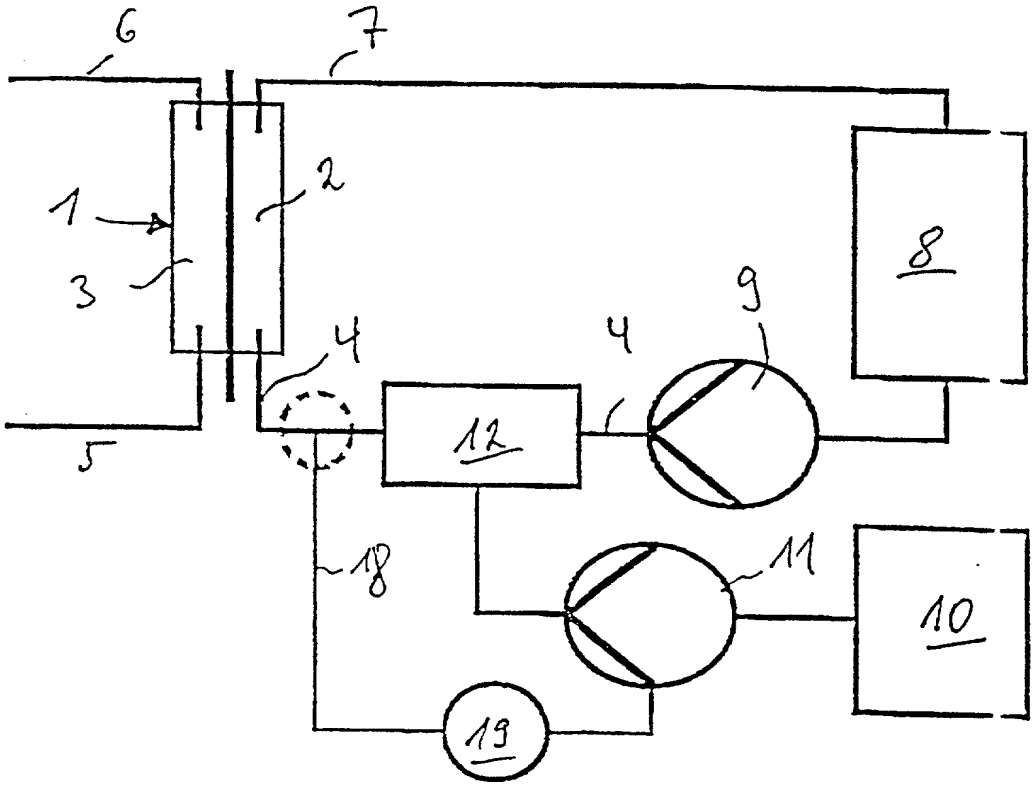

Fig. 1

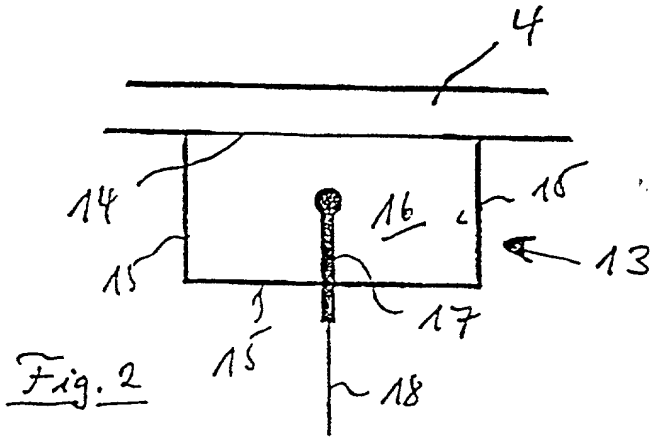

Fig. 2

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PTO/SB/01 (12-97)
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

[X] Declaration Submitted with Initial Filing OR [ ] Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	KONIG-003
First Named Inventor	Dieter Meissner
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD FOR ADJUSTING THE FUEL CONCENTRATION OF A FUEL MIXTURE CONTAINING ALCOHOL OR ETHER AS FUEL AND WATER; USED BY A FUEL CELL AND A FUEL CELL SYSTEM

(Title of the Invention)

the specification of which

[ ] is attached hereto

OR

[X] was filed on (MM/DD/YYYY) 10/22/1999 as United States Application Number or PCT International Application Number PCT/DE99/03384 and was amended on (MM/DD/YYYY) ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
198 50 720.8	DE	11/03/1998	[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)

[ ] Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 01815 OR ☐ Registered practitioner(s) name/registration number list

Name	Registration Number	Name

01815
PATENT TRADEMARK OFFICE

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label 01815 OR ☐ Correspondence address below

Name					
Address					
Address					
City		State		ZIP	
Country		Telephone		Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Dieter	MEISSNER

Inventor's Signature						Date	25.4.2001
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City		State		ZIP		Country	

☒ Additional inventors are being named on the ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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PTO/SB/02A (3-97)
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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 3 of 3

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname				
2-D Hans-Friedrich		OETJEN				
Inventor's Signature					Date	20.03.2001
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Post Office Address	D-52441 Linnich					
City		State	ZIP		Country	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname				
3-D Jürgen		MERGEL				
Inventor's Signature					Date	March 20, 2001
Residence: City	Jülich	State DE	Country		Citizenship	DE
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Post Office Address	D-52428 Jülich					
City		State	ZIP		Country	

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])		Family Name or Surname				
Inventor's Signature					Date	
Residence: City		State	Country		Citizenship	
Post Office Address						
Post Office Address						
City		State	ZIP		Country	